NUMERICAL AND EXPERIMENTAL STUDY OF A MULTIPHASE COLD BUBBLING BED REACTOR

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A lab scale bubbling fluidized bed reactor was simulated using a CFD model, aiming at investigating and ultimately matching its overall fluid dynamic behaviour and mostly the bubbles “footprints” on the pressure drop signal.

In order to validate the model, a cylindrical transparent reactor (PVC) has been assembled. This system, operating at ambient condition, was filled with aluminum oxide (Geldart group B particles) and homogeneously fluidized using compressed air flowing through a porous plate. A high frequency differential pressure gauge was used to measure the pressure drop across the bed. In addition, videos were recorded using a commercial camera and the generated dynamic slow motions frames combined with the still frames analysis contributed to the investigation of this system. Using Fluent-Ansys software, a 2D-Cartesian Two Fluid Model (TFM) was implemented, numerically verified and validated against experimental data using a Power Spectral Density (PSD) analysis of the pressure drop signal. Empirical data also suggested a minimum data capture time for pressure drop records and results showed that a 40 seconds sampling time was could be considered as a minimum threshold to capture a representative PSD distribution of the pressure oscillations. Based upon this finding, several simulations were performed to investigate the model sensitivity to the variation of some parameters specific to granular flows.

Specifically, the 2D TFM sensitivity was tested by varying the formulation for the solid pressure terms, the values of the experimental minimum fluidization velocity (used as a calibration point for the parametric drag law used in this study), and restitution coefficients for particles collisions. Related results have been plotted against each other along with the experimental ones and afterwards analyzed.

Comparison with the experimental data of the 2D-TFM model has proved to be satisfactory in matching the time-averaged pressure drop, the pseudo stationary bed expansion, its bubbles shape and ultimately capturing the total pressure drop “power”, evaluated as the integral of its Power Spectral Density (PSD).

The 2D model showed limitations in reproducing correctly the experimental PSD in the 0-10 Hz range, where the effect of bubbles are more significant. To overcome this limit, a 3-D version of this TFM model was implemented and tested. The analysis of the pressure drop spectrum showed how the 3D TFM model could overcome the aforementioned limitation of the corresponding 2D version. However, the quite coarse mesh size used to reduce the computational time did not allowed capturing the total power of the pressure drop oscillation. Our current efforts address the implementation and validation of a 3D-Dense Discrete Particle Model (DDPM) linked to this lab scale system such as to evaluate the performance and accuracy of this new approach with regards to the TFM previously tested. Such an approach would also contribute to reduce computational costs, this introducing the parcels concept. Collisions between these parcels is accounted throughout the soft-sphere (DEM) model where a linear spring-dashpot model is used. The effect of parcels number as well as DEM parameters variation on the pressure drop has also been investigated and analyzed.